

19. A Note on the Urostyle (*Os Coccygeum*) of the Anurous Amphibia. By GEO. E. NICHOLLS, D.Sc., F.L.S., late Professor of Biology, Agra College, Agra, India\*.

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(Text-figure 1.)

#### MORPHOLOGY.

It is, I believe, generally supposed that the neural canal in the Anura ends blindly in the urostyle. That this is not true of *Rana temporaria*—at any rate, in the young animal—I ascertained so far back as 1910, when examining sections (cut sagittally) through small frogs. In these sections the filum terminale is seen lying uncovered (except for connective tissue) upon the dorsal surface of the urostyle.

At that time, however, I paid no further attention to the matter, assuming that this was merely a transient condition in the young animal in which the absorption of the terminal portion of the filum terminale was not yet completed. I imagined that the resorption of tissues, which causes the disappearance of the tadpole-tail, would continue, and that, finally, what remained of the terminal filament would become entirely encased in bone. Unaccountably, it did not then occur to me to examine the adult urostyle.

While in India, however, I had occasion to examine closely the urostyle of *Rana tigrina*, the type commonly dissected in my laboratory there.

The urostyle of this species differs from that of *Rana temporaria* in the exceedingly variable occurrence of the paired perforations, which, in the latter species, admit of the exit of the tenth pair of spinal nerves. These perforations are, in *Rana tigrina*, frequently absent (text-fig. 1, *a, c, d*). When present (text-fig. 1, *b, X*.) they are extremely minute, and commonly, upon one side or the other, the external opening leads only into a blindly-ending canal.

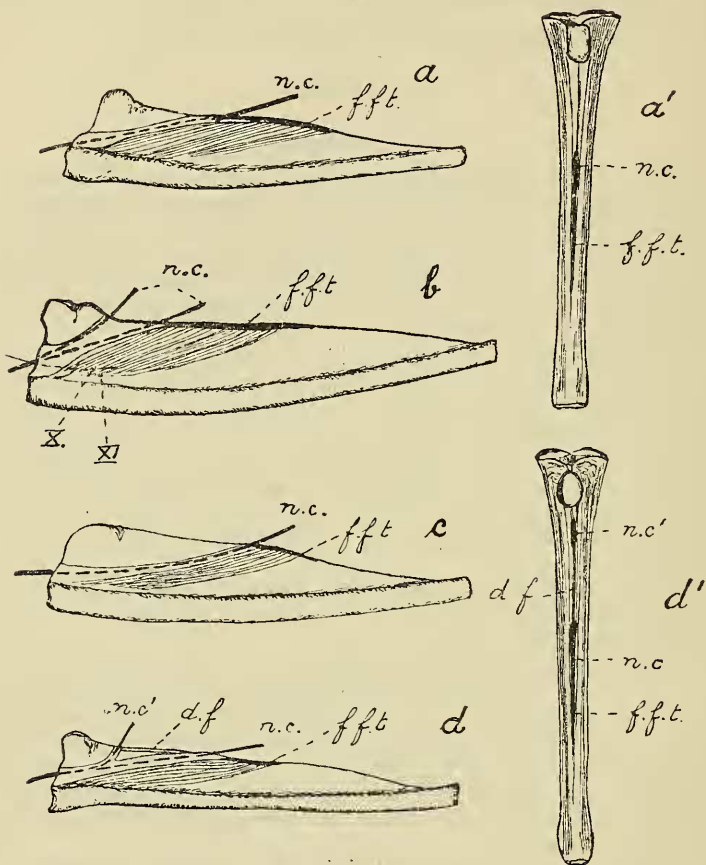
It was while engaged in studying the urostyle in connection with this matter that I noticed that the neural canal turned upwards very sharply, and apparently extended quite to the dorsal margin of the bone. The position and extent of this passage is clearly indicated (in the fresh condition), through the thin translucent bone, by the deeply pigmented meningeal sheath of the filum terminale and its related blood-vessels.

A recollection of the perforated condition of the urostyle which I had observed in the young *R. temporaria* led me to examine the upper margin of the urostyle with the aid of a powerful lens.

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The examination immediately revealed the fact that for a considerable distance upon the narrow crest of the bone there

Text-figure 1.



In *a* the position and extent of the neural canal, as seen typically in lateral view, of the urostyle of *Rana tigrina* are represented,  $\times 1\frac{1}{2}$ ; *b*, *c*, *d* represent variations not infrequently found, also  $\times 1\frac{1}{2}$ . In *a'*, *d'* the urostyles *a* and *d* are represented as seen from above, but the size of the dorsal opening of the neural canal and the width of the dorsal furrow (in which lies the free end of the filum terminale) are greatly exaggerated.

*n.c.* indicates a bristle inserted in the neural canal and emerging dorsally. (In *b* the neural canal within the urostyle is short and wide, and the extreme positions, forward and backward, of the bristle are shown.) Actually, within the canal, the bristle is indicated by an interrupted line.

The black line *fft.* indicates the extent of the dorsal furrow (the uncovered posterior extension of the neural canal) which lodges the end of the filum terminale; in *d* (and *d'*) a part of this furrow has been roofed in, leaving above it only a very shallow groove, *d.f.*, connecting an anterior opening of the neural canal, *n.c.'*, with the more posterior opening, *n.c.*

was a well-marked furrow. This furrow, which was deepest anteriorly, began at a point just in front of the place where the neural canal appeared to reach the dorsal surface (text-fig. 1, *a, a'*).

The passage of a bristle definitely established the further fact that the neural canal in the specimen studied did not end blindly, but, near the end of the first third of the length of the bone, opened out into this groove or furrow upon the dorsal surface. Thence it was continued nearly to the end of the middle third of the urostyle as the open groove referred to (text-fig. 1, *f, f.t.*). In the fresh condition this groove is occupied (as I afterwards determined by means of serial sections) by the extremity of the filum terminale, which thus has a position precisely similar to that which it occupies in the young *R. temporaria*. The open groove, extending approximately along the middle third of the dorsal surface of the urostylar crest, is thus a posterior uncovered extension of the neural canal.

An examination of a large number of urostyles (34) of specimens of *R. tigrina* showed that this terminal opening of the neural canal was an absolutely constant feature, occurring even in specimens showing marked abnormality of the vertebral column.

A point of difference noted, however, was that in some specimens the dorsal furrow was of much greater extent than in others. In all it ended at approximately the same point, but in some the furrow began nearly at the anterior extremity of the bone (text-fig. 1, *b, d, d'*). In some instances the dorso-ventral diameter of the neural canal was unusually large, and the canal then extended to the dorsal margin of the urostyle at a point much nearer to its anterior end (text-fig. 1, *b*). In other examples the neural canal, though not of larger calibre than usual, passed dorsalwards much more abruptly. In these latter the dorsally situated (exposed) groove for the filum terminale was, relatively, much longer. A condition, varying in a manner precisely opposite to this, also occurs in which the filum terminale passes backwards in a direction much more nearly approaching the horizontal. In this case the uncovered extremity of the neural canal is, relatively, extremely short (text-fig. 1, *c*). In those examples, however, in which the neural terminal filament runs for a considerable distance in this groove upon the upper margin of the urostyle, it is not always uncovered for the whole of that distance. Not infrequently a delicate layer of bone roofs in a portion of the groove anteriorly. In a single specimen there was a small dorsal aperture leading into the neural canal and situated far anteriorly, separated from the open stretch of groove by an intervening bony roof (text-fig. 1, *d, d'*).

Such variation in the extent of the dorsal open groove may perhaps indicate that the number of fused vertebrae in this region, in which the neural arch is incomplete, is quite variable. Behind the furrow the urostyle must, presumably, be regarded as composed of fused centra only.

On account of the severity of the drought prevailing at the

time, I was unable to obtain specimens of other locally occurring species of Anura, except a single specimen of *Bufo melanostictus*. Subsequently, just as I was leaving India, however, I received other specimens of *Bufo melanostictus* (2) from Professor Woodland of Allahabad, and of *Bufo melanostictus* (4) and *B. andersoni* (2) from Professor Youngman of Lucknow. From London, Mr. Biddolph sent me the hinder parts of the vertebral column of *Rana esculenta* (2), *R. temporaria* (2), and *Bufo vulgaris* (1).

I have also examined a number of skeletons of the two latter species since my return to England.

In every case a careful examination of the urostyle showed that the condition of the neural canal was precisely similar to that described above as obtaining in *R. tigrina*. In the case of certain of the smaller specimens (e. g. *R. temporaria*), the aperture through which the filum terminale emerged from the tubular part of the neural canal is extremely fine, and the succeeding dorsal furrow is represented by a very narrow crevice. In several cases, although the opening could be made out, it was too fine even for the passage of a hair.

I have sectioned also the decalcified urostyle of a single specimen of *Hyla arborea*. The sections establish indubitably that, in this specimen also, the filum terminale extends on to the dorsal surface of the urostyle, upon which it lies altogether uncovered by bone, exactly as in the similar sections of *R. temporaria* and *R. tigrina*.

There can be, I think, no doubt, therefore, but that this condition of the urostyle and filum terminale will prove to be normal for the Anura generally.